

Caves as a window on land-atmosphere coupling in the carbon cycle

Supervisors

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Project description:



A slice of karst

Solutional karst forms and exposed epikarst in a limestone quarry located in the Capo San Vito mountains, NW Sicily

Section through conduit with abundant speleothems, soils and organic matter (~10 cm width).

The sensitivity of soil carbon to changing climate sees a lot of attention from both a measurement and modelling perspective. Among the critical concerns is the partitioning of the inorganic carbon and the transfer of carbon to the atmosphere by soil CO₂ efflux and downward flux of dissolved inorganic carbon via the unsaturated zone to groundwater.

Caves offer a unique window on the pathways of carbon in the vadose zone (soils and unsaturated zone). Cave dripwater chemistry provides valuable information about the downward transport of carbon from the various organic and inorganic carbon pools above. Secondary calcite precipitates (speleothems, such as stalactites and stalagmites) preserve a wide range of proxy data that can be used to infer valuable information about biogeochemical processes above and within the cave: $\delta^{13}C$, $\delta^{14}C$, organic matter fluorescence and lipid biomarkers (Wong and Breecker, 2015).

Radiocarbon is a key parameter used to study turnover rates in the soils, partitioning of carbon sources and transport mechanisms. Recently, there has been renewed interest in radiocarbon measurements in cave and karst environments, prompted by the use of speleothem ^{14}C to provide long-term records of past atmospheric activity. Such data is pivotal in archaeology, ocean sciences, geophysics and paleoclimatology. Critical, however, is the extent to which there has been a constant contribution of carbon from the host limestone in the soil and vadose zone.

This PhD project will investigate on the paths of carbon, especially ^{14}C , through the soil and vadose zone in contrasting environments (temperate and low latitude). Longer-term monitoring will be undertaken near Bristol (Mendips), with field visits also planned to support previous work in the Bahamas (Hoffmann et al, 2014).

It is expected that the researcher will be instrumental in monitoring drip water discharge, cave pCO₂, trace element and carbon isotope variation in cave settings. This will be supplemented by analysis of the mineral, organic, gaseous and aqueous phases in the soil zone above. The successful candidate will be able to take advantage of a wide range of state-of-the-art facilities offered at Bristol and Exeter for isotope analysis and biomarker characterisation. Water tracing experiments

will also be conducted, drawing upon expertise of hydrogeologists at the British Geological Survey, Wallingford.

References:

Hoffmann, DL et al. (2010) Towards radiocarbon calibration beyond 28 ka based on speleothems from the Bahamas, *EPSL* 289, 1-10

Wong CI, Breecker DO (in press) Advancements in the use of speleothems as climate archives. *Quaternary Science Reviews*